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Shaping a Clean Future with the 'Internet of Energy Things': ubitricity's MobileCharging System

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Summary

ubitricity's MobileCharging system proposes a solution for tomorrow's energy economy as well as transportation sector. The company has developed an intelligent charging cable that contains a mobile, calibrated electricity meter: the SmartCable. This technology enables individual tariffing of electric vehicles (EVs) and thus monitoring and controlling their energy consumption. Users obtain the possibility of choosing their own mobile electricity provider and charging their electricity of choice at every ubitricity charging spot. By shifting metering and communication technology from the charging station to the cable, the charging spot is simplified into a lean SimpleSocket. Their compact measurements and easy installation allow for a roll-out practically everywhere.

The system allows for efficient energy usage and seamless integration of EVs into the smart grid, thus offering new business models and solutions for the current challenges of the energy as well as the transport sector.

Keywords: electric mobility, electric vehicles, internet of things, smart city

More and more electricity from renewable sources, fluctuating production e.g. from solar or wind energy and a constantly rising number of production bases – that is the energy economy's future. The organisation of this new, more flexible system poses other challenges and difficulties than the conventional, hierarchic system, where centralised power plants produced electricity according to itinerary and schedule. In Germany, rising numbers of wind power plants and PV installations have already led to a considerable alteration of this system – and the development has only just begun. Vehicles whose consumption can be regulated and controlled during charging transactions are very valuable for designing a more flexible and intelligent energy distribution system.

The development of mobility in transportation is facing similar changes and challenges. In tomorrow's smart cities, transport will have to be quiet. It will have to be efficient, connected, and maybe even autonomous. And above all: it will be green - which means free of emissions. Electric mobility can be an answer to these challenges – if it is powered by green electricity which stems from renewable sources. In the majority of cases, this cannot yet be guaranteed as there is no free choice of electricity provider and tariff when charging

one's electric vehicle (EV). This calls for a thorough reformation of charging infrastructure, making it intelligent, cost-efficient and easy to roll out throughout cities and rural areas.

ubitricity's MobileCharging system proposes a solution to these challenges and provides the missing link between visions of future electricity production, distribution and storage and clean transportation methods. Essentially powered by an intelligent charging cable with integrated mobile electricity meter, the MobileCharging system provides a system solution for EV charging infrastructure, consisting of the SmartCable (the intelligent charging cable), the SimpleSocket (the simplified charging spot), and a back-end software for data management and billing. The system proposes several structural changes to today's electric mobility landscapes and enables new business models for energy providers as well as corporate fleet managers or condominium managers.

In the following paper, I will introduce the MobileCharging system and the most important fundamental changes it proposes to today's structures. Possible business models based on the system and different examples of implementation will be outlined.

1 The Infrastructure

This section presents the more technological aspect of the solutions ubitricity is offering to the challenges mentioned above. The theory of a future charging infrastructure and the demands it has to answer to are shortly presented, followed by an outline of the systemic logic and functionality of the Mobile Charging system and fundamental aspects of the virtual power grid and Internet of Energy Things.

1.1 Demands to future charging infrastructure

Electric mobility can contribute significantly to making visions of green electricity supply and emission-free transportation a reality. It all depends on how mobility is organised and how EV charging infrastructure can tie the sectors of energy production and transportation together.

In order to maximise the effects of decentralised storage that EVs can provide, the time vehicles are connected to the grid has to be maximised. Put more concretely, this means that EVs should be connected to the electricity grid anytime and wherever they park – charging infrastructure would have to be rolled out ubiquitously and anywhere vehicles park: at work, at private homes and in public spaces. This would also avoid extra traffic as EV drivers would not have to make extra ways in order to find charge points. Especially in cities and urban areas, evening out traffic loads at peak times can be an important issue.

As of today, the major impediment to rolling out ubiquitous charging infrastructure are the costs. Charging infrastructure is expensive in itself and often even causes additional costs due to extra construction works necessary when installing the charging pillars. Furthermore, maintenance costs of the technologically complex charging pillars are high and maintenance processes are complicated. Charging infrastructure has to shrink not only in size, but also in technological complexity in order to become economically feasible.

The most important asset future charging infrastructure has to offer for supporting the energy transition is the supply of green electricity to electric vehicles – everywhere they park. Electric mobility can only become really green and free of emissions when powered completely and exclusively by green electricity produced from renewable energies.

Charging infrastructure can also make a contribution to converting today's electricity grids into smart grids. By monitoring the electricity load and the demand of electricity in the grid on the one hand, and managing charging transactions accordingly on the other hand, charging infrastructure can become a decisive tool to maintain grid stability in the face of fluctuating renewable energy production.

Building up on these smart grid functionalities, charging infrastructure should enable dynamic pricing models for charging and discharging processes so that EV users can profit from the storage space they are offering the grid with their EV.

1.2 Mobile Metering: What does it mean and why does it make sense?

The MobileCharging system, an integrated system solution consisting of hardware, associated software and backend management, is ubitricity's answer to the afore-mentioned demands of an ideal future charging infrastructure.

The integration of metering and communication technology into the cable instead of the charge points reduces costs dramatically and essentially enables a ubiquitous roll-out of charge points in rural as well as urban areas. As every EV is bundled to a mobile electricity contract and tariff, new pricing and business models are made possible as well as efficient usage of the distributed storage capacity EVs offer.

The following section gives an outline of the technical functionalities and usability of the MobileCharging system as well as an overview of the software processes. Picking up on these explanations, the idea of the 'Internet of Energy Things' will be sketched briefly.

1.2.1 Functionalities of the MobileCharging system

The MobileCharging system revolves around an intelligent charging cable, enhanced by a mobile, calibrated electricity meter: the SmartCable. Every SmartCable is tied to a mobile electricity contract held by the respective owner of the SmartCable. Apart from the mobile electricity meter, the SmartCable contains a modem for mobile communication: the technology necessary for charging and billing is shifted completely from the charging spot into the cable.

In order to initiate the charging process, the user connects the SmartCable to the charging spot, a technologically simplified SimpleSocket. The SimpleSockets contain no technology for billing and data communication, which makes them economically feasible and easy to install. When the SmartCable is connected to the charging spot, the charging transaction is authorised automatically via mobile communication with the ubitricity back-end system. Electricity is released and metered down to the kWh and in real-time. When the charging process has ended, the SmartCable automatically transmits the transaction data to the ubitricity back-end for billing. This is processed with a Public Key Infrastructure (PKI) as is used in online banking processes, securing the billing process and safeguarding data protection.

All charging transactions are processed for billing in the ubitricity back-end, conform to standard regulations of the energy economy. Users receive one monthly bill per SmartCable instead of having to pay for every single transaction separately, as with conventional charging infrastructure. They can access all their charging and billing data online in the ubitricity user portal, the ConnectivityManager, complemented by other useful features such as a charge point search engine. Users are thus given full control over their tariffs and transactions. They receive a monthly, transparent invoice for all their transactions, making it easy to keep track. The billing process is certified according to legal standards and data protection is safeguarded by using a PKI, as mentioned before.

As the SimpleSockets are easy to install and require only a small initial investment, they allow for a ubiquitous roll-out of EV charging infrastructure practically everywhere electric vehicles park on their daily routine and a connection to the power grid is available. Their maintenance costs are considerably lower than those of conventional charging stations as they contain no complicated and damageable technology. Their compact measurements allow for installation in different variants and locations – wall-mounted, in a stand-alone version or even integrated into light poles. This makes them applicable in private, semi-public and public spaces.

The SmartCable is designed for usage at the SimpleSockets, but equipped with a standardised Type-2 plug and thus also compatible with conventional charging infrastructure. Customers can book the ubitricity E-Roaming option as an addition to their mobile electricity contract, receive an RFID token and can charge at more than 40.000 third-party charging spots in Germany and other European countries. All charging transactions realised at third-party infrastructure are still recorded on the same monthly invoice – a practical and transparent solution.

1.2.2 Building up on the technology: the virtual electricity grid and Internet of Energy Things

Essentially, the ubitricity system transfers the logic of mobile communication to the market of electric mobility: Electricity meters are allocated precisely to the user (one user – one electricity meter) instead of

maintaining fixed to the charge point (one user – many electricity meters). In order to process the data generated by this logic, ubitricity manages separate accounting regions, in accordance with the accounting regions of German DSOs. Transactions issued within these accounting regions are managed by ubitricity, conform to standard processes of the German energy industry.

This makes the virtual power grid the construction that enables supplying mobile consumers with mobile electricity. It is fitted like a layer over the physical power grid, using standard market communication processes of the energy industry in order to integrate the mobile consumers into the electricity grid. Electricity is metered by the mobile meter integrated in the SmartCable, transported to the ubitricity back-end and processed for communication to the Distribution System Operator (DSO) and to the balancing coordinator of the grid, who will both play a crucial role in the construction of smart grids in the future.

In the virtual power grid, the metering point is mobile and connects to the grid at various locations – it is no longer attached to the charging point, but to the cable. The charge point itself merely provides the technological and concrete access to the electricity grid, instead of also taking an active position within the energy industry landscape.

The idea of this virtual power grid is directly connected to the integration of electric vehicles into the smart grid as it allows for dynamic pricing models and demand-side management while at the same time minimizing the transaction cost. This is what we at ubitricity call the Internet of Energy Things, in our case more an internet of mobile consumers – an internet of electric vehicles, equipped with individual contracts and tariffs. Vehicles are connected not only between each other, but also with other electronic devices integrated into the smart grid. The car's charging demand is recorded by the cable and communicated to the DSO via ubitricity in real-time – something conventional charging infrastructure is unable to render. This way, the grid can "know" about the different demands in the system and balance supply with demand at different locations at the same time – a complete innovation to the world of electric mobility.

Then of course, this is only one side of the coin. In order to really make EV smart grid integration work, business and pricing models have to be developed to fit this technological aspect of the solution. Dynamic pricing models have to make users benefit from charging and discharging processes, and electricity providers as well as electric mobility service providers have to be enabled to offer new products and benefit from new business models based on smart charging.

Mobile Metering makes it possible to develop precisely these kind of solutions and ideas, some of which we at ubitricity are already putting into practice - as will be outlined in the following section.

2 The Target Groups and Business Models

Electric mobility opens up the electricity market and energy industry to new players and new kinds of users, bringing along new demands and interests – the mobile meter is practically the realisation of these new demands and the adequate tool to make them fit in with each other.

This section will briefly outline different business models enabled by the MobileCharging system, some of which we are already putting into practice.

2.1 Opportunities for utilities: Providing mobile electricity to mobile consumers

For utilities, Mobile Metering can provide opportunities to offer smart and innovative electricity products to their customers. The MobileCharging system gives EV users the chance to choose their own mobile electricity contract and tariff – utilities can enter the growing market of electric mobility without additional effort.

This special use case is addressed by the ubitricity WhiteLabel solution for utilities. Utilities purchase ubitricity hardware in their own corporate design and offer SmartCables along with the matching mobile electricity tariff to EV users. The web app and invoicing services are designed in line with the utility's corporate branding – a whole new product for energy providers. ubitricity manages billing and data communication processes according to data protection standards – thereby supporting utilities in their entrance to the market of electric mobility and helping them develop new, digitalised energy products.

The WhiteLabel solution can also form the basis for dynamic pricing models and smart energy services of the future. As Mobile Metering can in perspective be combined with technologies for demand-side management and smart charging, utilities can develop new pricing models and tariffs to mirror these developments. The ubitricity solution is perfectly compatible with these future developments and allows users as well as utilities to prepare for the smart energy services of the future even today and participate actively in the process – for example by supplying green electricity to EVs.

ubitricity places special value on making sure that the electricity offered on our mobile electricity platform comes from renewable energies – which, as stated before, is one of the preliminary conditions for electric mobility to be green and for the energy transition to be successful. This gives users the chance to actually know about and control which electricity their car is charging – whereas utilities can profile themselves as active drivers of the energy transition.

The ubitricity MobileCharging system presents a perfect complementation of conventional, existing charging infrastructure and fast-charging infrastructure: a ubiquitous network of affordable and simple charging spots which can be installed practically anywhere and intelligent business models to go with it. Customers can still make use of already-existing conventional and fast-charging infrastructure.

2.2 Corporate fleets and fleet service providers: greening up company routines

The MobileCharging system makes it easy for corporate fleets and fleet service providers to integrate EVs into their business routines. Companies can equip their electric fleet vehicles with SmartCables, bundled to individual mobile electricity contracts. All charging transactions per car are summed up in one invoice – regardless of when and where electricity was charged. This way, employees can charge at different charge points at different offices, at home or on the go – without paying for anything in advance and without additional effort for the company accounting.

The company or fleet manager receives one monthly bill per vehicle – a transparent overview of aggregated charging data of the vehicle. This way, the employee's data is protected without an ensuing lack of transparency for the employer. The invoices can be assigned internally to the cost point "Fleets" and processed within the normal company accounting – simple and transparent. In this manner, corporate fleets can integrate EVs without additional efforts and complications for the companies themselves.

The simplicity and reduced size of the ubitricity SimpleSockets allow for installation almost anywhere – also at employees' homes. Due to mobile metering technology, employees can charge at home without having to pay for it themselves. The electricity is billed directly to the company and the employee as charge point provider receives an automatic reimbursement for the exact amount of energy charged at their charging spot.

2.3 Condominiums and real estate managers: creating additional value for real estate objects

One of the major impediments to developing a ubiquitous network of charging spots in cities is the complicated construction and billing situation in condominiums and apartment buildings. Apart from the often complicated and expensive installation of charging spots, in many cases real estate owners and managers still have to give electricity away for free. So far, they are missing a solution to bill the electricity charged at a charging spot separately from the overall electricity bill of the building.

The MobileCharging system is the perfect solution for this situation. Owners and managers can install the economically feasible charging spots in different installation variants: wall-mounted for inside and outside use or in a stand-alone version for the parking space outdoors. Tenants purchase a SmartCable with bundled mobile electricity contract and electricity costs arising at the charging spots are billed directly to the user. The charge point providers receive an automatic reimbursement for the electricity charged at their charging spots. No extra efforts necessary and no need to worry about electricity being given away for free.

3 The Implementation

Several companies and cities have already put the MobileCharging in use, realising the different use cases in different contexts. Some best practice examples are presented in the following sections.

The different examples and contexts illustrate the complexity of the field of electric mobility, the different requirements that different customers bring along and the necessity of a wide and diverse range of service providers on the market. By cooperating with other service providers in the field, as well as energy providers, ubitricity has managed to create different products that suit the demands of different players in the field.

3.1 The WhiteLabel solution: Iserlohn, North Rhine Westphalia

Deploying ubitricity's WhiteLabel solution, the municipal utility of Iserlohn in North Rhine Westphalia has installed around twenty charge points throughout the town. The SimpleSockets have been installed in different variants according to different requirements in the city, all of them in the municipal utility's own corporate design.

The utility in Iserlohn also offers mobile electricity along with SmartCables and the charge points they have installed – that way, citizens of Iserlohn and the surrounding municipalities have easy access to a full service system solution featuring their own regional service providers.

By making use of the ubitricity WhiteLabel solution, the municipal utility has placed itself as a role model within the field of electric mobility in Germany, especially concerning the role of municipal utilities in this process. Other municipal utilities in towns of comparable sizes have followed their model and also rolled out ubitricity SimpleSockets, such as the cities of Unna and Schwerte, both North Rhine Westphalia.

3.2 Corporate fleet products: DES and Alphabet

Digital Energy Solutions, a joint venture of the BMW Group and Viessmann Group, just recently announced that they are counting on the MobileCharging solution to offer electric mobility services to their fleet customers, such as Alphabet GmbH. DES offer integrated energy efficiency services to small and middle-sized companies in order to maximise energy efficiency in business routines – be it in the field of electricity, heating or water usages.

Electric mobility is an important asset in this context as it can contribute importantly to reducing companies' CO2 footprints. In order to offer their customers integrated, easy-to-use services in this field, DES has decided to work with ubitricity's MobileCharging system, profiting from the comfortable billing and data management services. Charging infrastructure is an important feature of this offer as it is one of the major impediments to the implementation of electric mobility in general.

Similarly as with utilities, ubitricity is offering DES a WhiteLabel solution. The company provides their customers with SmartCables and SimpleSockets in their own corporate design whereas ubitricity handles charging and billing services as well as data management – a B2B2B/C approach put into practice.

3.3 Charging infrastructure for municipalities: the City of London

London is a very special example for the deployment of the MobileCharging system. Only recently, in summer 2016, have different boroughs of London (Hounslow, Kensington and Chelsea as well as Westminster) started to roll out ubitricity charging infrastructure – in its most special variant: integrated into light poles.

Due to their compact measurements, it is possible for the ubitricity SimpleSockets to even fit into the slim light poles in the central boroughs of London. As the light poles are already connected to the power grid, no extra works are required to connect the charge points to the grid. This way, charge points can be created very fast without using up additional space and without requiring a reserved parking bay for EV users.

Over the last few months, more than 100 charge points have been installed throughout the city – even in listed boroughs were the roll-out of charge points would otherwise not be possible.

4 Conclusions and a look to the future

As this paper has aimed to show, there is much to gain by re-thinking the way charging infrastructure is organised both technologically and structurally. By modularizing the technology necessary for charging and

splitting costs between EV users and charge point providers, ubitricity has created a scalable solution that is suitable for different contexts.

Central to the large-scale implementation of electric mobility and its thorough adoption by the users is the development of intelligent, user-centred services that meet different requirements users might have. Also, the reduction of costs for charging infrastructure is a major issue in order for electric mobility to become economically feasible. In order for this development to be completed, many steps are yet to be taken. Regulatory and political developments have to support innovation and development of new technologies and solutions in the private sector.

Future developments are of course difficult to predict, but it is obvious that the market for electric mobility, and especially for digital services in this market, has great potential. Of course, the major issue in this field is the development of smart services and technologies for EV smart grid integration, which ubitricity is already a part of due to the exact allocation of electricity meters to individual, mobile users.

In the future, electricity meters might not even have to be integrated into the cable, but might become part of the equipment of cars itself: on-board electricity meters. This would simplify the hardware and technology even further and involve OEMs actively in the process of shaping charging infrastructure for electric mobility.

Authors

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